



**UNIVERSITI PUTRA MALAYSIA**

**EFFECTS OF COCOA BUTTER, PALM FRACTION AND EMULSIFIER  
MIXTURES ON THE QUALITY PARAMETERS OF DIFFERENT  
CHOCOLATE FORMULATIONS**

**BAKTI KUMARA**

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**By**

**BAKTI KUMARA**

**Thesis Submitted to the School of Graduate Studies,  
Universiti Putra Malaysia, in Fulfillment of the Requirement for  
the Degree of Master of Science**

**June 2003**



### *Special Dedication*

*This Thesis is dedicated to  
My beloved wife and son: Husna and Rifqi,  
My affectionate parents: Papa & Mamah,  
My brothers and sister: Budi, Nuki and Ina  
For their patient, love and support*

Abstract of thesis presented to the Senate of Universiti Putra  
Malaysia in fulfilment of the requirement for the degree of  
Master of Science

**EFFECTS OF COCOA BUTTER, PALM FRACTION AND  
EMULSIFIER MIXTURES ON THE QUALITY PARAMETERS OF  
DIFFERENT CHOCOLATE FORMULATIONS**

**By**

**BAKTI KUMARA**

**June 2003**

**Chairperson : Professor Jinap Selamat, Ph.D.**

**Faculty : Food Science and Biotechnology**

The physico-chemical characteristics of cocoa butter (CB), palm mid-fraction (PMF) and palm kernel stearin (PKS) in fat-based chocolate formulation in the presence of sorbitan tristearate (STS) have been studied. Triacylglycerols (TAGs), fatty acid methyl esters (FAMES), thermal behaviour, polymorphic form, solid fat content (SFC), hardness/texture properties, rheological behaviour, microstructure properties, bloom test, and sensory properties were determined to evaluate quality properties of palm-based chocolate. The results show that the addition of STS into fat system could significantly inhibit the polymorphic transformation during temperature transition. It is due to the significant influence in increasing the crystal stability.

This study showed that the melting profiles of fat mixtures with the presence of STS were different due to the rapid melting at room temperature (30°C), so resulting in the softness of chocolate products. Most of CB, PKS and STS mixtures have a strong tendency to produce two distinctive  $\beta$  and  $\beta'$  polymorphs. These results provide strong evidence to indicate incompatibility between those fats, which causes softness in chocolate and confectionery products. By using response surface methodology (RSM), it was found that a ratio of 90CB:10PMF:2.5STS was the optimum formulation for the best physical and chemical characteristics of fat system.

The concentrations of TAGs of chocolate's fat were changed, causing the polymorphic transformation to take place during storage. However, only the composition of the main TAGs (POP, POS, SOS) significantly influence the type of polymorphic form, whereas fatty acids composition determined the type of TAGs formed. Chocolate containing CB (control) consisted of only  $\beta$  crystals at all times. However, chocolates containing CB and PMF mixtures were found to have both  $\beta'$  and  $\beta$  during storage period. The existing of two crystal forms ( $\beta' + \beta$ ) and the transition of  $\beta'$  into the more stable  $\beta$  crystal had caused bloom formation. STS at 1.25% and 2.5% were found to

inhibit effectively bloom formation during storage. The sensory evaluation of palm-based chocolates showed that texture score was significantly affected by both PMF concentration and onset of melt, but STS did not have any significant effect on each sensory attribute.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN CAMPURAN LEMAK KOKO, FRAKSI MINYAK KELAPA SAWIT DAN PENGEMULSI TERHADAP CIRI KUALITI DALAM FORMULASI COKLAT YANG BERBEZA**

**Oleh**

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Sifat fiziko-kimia lemak koko (CB), fraksi tengah minyak kelapa sawit (PMF) dan kernel stearin minyak kelapa sawit (PKS) dalam formulasi coklat berasas lemak dengan kehadiran sorbitan tristearat (STS) telah dikaji. Triasilgliserol (TAGs), asid lemak metil ester (FAMEs), sifat termal, bentuk polimorfik, kandungan lemak pejal, ciri kekerasan/tekstur, sifat reologi, ciri mikrostruktur, ujian bloom dan ciri sensori telah ditentukan untuk menilai ciri kualiti coklat berasas minyak kelapa sawit. Hasil penyelidikan menunjukkan bahawa penambahan STS ke dalam sistem lemak telah menghalang perubahan polimorfik dengan ketara ketika perubahan suhu. Ini adalah disebabkan oleh pengaruh ketara dalam peningkatan kestabilan kristal.



Kajian juga telah menunjukkan bahawa profil melebur campuran lemak dengan kehadiran STS adalah berbeza disebabkan peleburan yang cepat pada suhu bilik (30°C), dan ini menyebabkan produk coklat menjadi lembik. Kebanyakan campuran CB, PKS dan STS mempunyai kecenderungan yang kuat untuk menghasilkan dua polimorf yang berbeza iaitu  $\beta$  dan  $\beta'$ . Keputusan ini memberikan bukti yang kukuh tentang ketidak sesuaian di antara lemak tersebut, yang seterusnya menghasilkan produk coklat dan konfeksi yang lembik. Teknik “response surface methodology” (RSM), telah mendapatkan bahawa kombinasi 90CB:10PMF:2.5STS telah menghasilkan sifat fizikal dan kimia yang terbaik dalam sistem lemak.

Kepekatan TAGs dalam lemak coklat telah berubah dan itu mengakibatkan berlakunya perubahan polimorfik semasa penyimpanan. Walau bagaimanapun, hanya komposisi utama TAGs (POP, POS, SOS) didapati mempengaruhi dengan ketara jenis bentuk polimorfik dan komposisi asid lemak menentukan jenis TAGs yang terbentuk. Coklat yang mengandungi CB (kawalan) didapati hanya mengandungi kristal  $\beta$  pada setiap masa. Sebaliknya, coklat yang mengandungi campuran PMF dan CB mempunyai kristal  $\beta'$  dan  $\beta$ . Kehadiran dua jenis kristal ( $\beta' + \beta$ ) dan perubahan  $\beta'$  kepada kristal  $\beta$

yang lebih stabil telah menyebabkan pembentukan bloom. STS pada 1.25% dan 2.5% didapati menghalang pembentukan bloom dengan berkesan. Penilaian sensori coklat berasas minyak kelapa sawit menunjukkan bahawa kepekatan PMF dan permulaan melebur yang cepat mempengaruhi dengan ketara skor untuk tekstur. Walau bagaimanapun, STS tidak menunjukkan kesan yang ketara terhadap setiap ciri sensori.

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I certify that an Examination Committee met on 16<sup>th</sup> June 2003 to conduct the final examination of Bakti Kumara on his Master of Science thesis entitled "Effects of Cocoa Butter, Palm Fraction and Emulsifier Mixtures on The Quality Parameters of Different Chocolate Formulations" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any degree at UPM or other institutions.

A handwritten signature in black ink, appearing to read 'Bakti Kumara', written over a horizontal line.

**BAKTI KUMARA**

Date: 26 SEP 2003

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